

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation;

a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 40 to 65 degrees;

a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

a phase plate provided on an outer surface of said upper substrate;

a polarizing plate provided on an outer surface of said phase plate;

and

wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 53 nm at said twist angle of about 40 degrees and about 10 to 64 nm at said twist angle of about 65 degrees, respectively.

2. The device of claim 1 wherein said liquid crystal layer has a retardation in the range of about 200 to 350 nm.

3. The device of claim 1 wherein said phase plate has a retardation in the range of about 280 to 470 nm.

5 4. The device of claim 1 wherein said phase plate has a slow axis azimuth in the range of about 30 to 75 degrees.

5. The device of claim 1 wherein said phase plate has an Nz coefficient of less than about 0.5.

10 6. The device of claim 1 wherein said polarizing plate has an absorption axis azimuth in the range of about 30 to 90 degrees.

7. The device of claim 1 wherein said liquid crystal layer has a retardation in the range of about 380 to 450 nm at a twist angle in the range of about 45 to 50 degrees.

15 8. The device of claim 1 wherein said phase plate has a retardation in the range of 280 to 340 nm at a twist angle in the range of about 45 to 50 degrees.

9. The device of claim 1 wherein said phase plate has a slow axis azimuth in the range of about 5 to 50 degrees at a twist angle in the range of about 45 to 50 degrees.

10. The device of claim 1 wherein said polarizing plate has an absorption axis azimuth in the range of about 0 to 10 degrees and in the range of 125 to 180 degrees at a twist angle in the range of about 45 to 50 degrees.

11. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation;

a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 75 to 120 degrees;

a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

a phase plate provided on an outer surface of said upper substrate;

a polarizing plate provided on an outer surface of said phase plate;

and

wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 74 nm at said twist angle of about 75 degrees and about 10 to 101 nm at said twist angle of about 120 degrees, respectively.

5           12. The device of claim 12 wherein said liquid crystal layer has a retardation in the range of about 200 to 310 nm.

13. The device of claim 12 wherein said phase plate has a retardation in the range of about 320 to 460 nm.

10           14. The device of claim 12 wherein said phase plate has a slow axis azimuth in the range of about 105 to 145 degrees.

15           15. The device of claim 12 wherein said polarizing plate has an absorption axis azimuth in the range of about 25 to 65 degrees.

16. The device of claim 12 wherein said liquid crystal layer has a retardation in the range of about 200 to 310 nm at a twist angle in the range of about 75 to 80 degrees.

17. The device of claim 12 wherein said phase plate has a retardation in the range of about 320 to 460 nm at a twist angle in the range of about 75 to 80 degrees.

18. The device of claim 12 wherein said phase plate has a slow axis azimuth in the range of about 105 to 145 degrees at a twist angle in the range of about 75 to 80 degrees.

19. The device of claim 12 wherein said polarizing plate has an absorption axis azimuth in the range of about 25 to 65 degrees at a twist angle in the range of about 75 to 80 degrees.

20. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation;

a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 0 to 30 degrees;

a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

a phase plate provided on an outer surface of said upper substrate;

a polarizing plate provided on an outer surface of said phase plate;

and

wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 32 nm at said twist angle of about 0 degrees and about 10 to 47 nm at said twist angle of about 30 degrees, respectively.

21. The device of claim 20 wherein said liquid crystal layer has a retardation in the range of about 200 to 370 nm.

22. The device of claim 20 wherein said phase plate has a retardation in the range of about 10 to 240 nm.

23. The device of claim 20 wherein said phase plate has a slow axis azimuth in the range of about 95 to 175 degrees.

24. The device of claim 20 wherein said polarizing plate has an absorption axis azimuth in the ranges of about 0 to 25 degrees and about 165 to 180 degrees.

25. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 40 to 65 degrees and a light diffusive reflective electrode having recesses and

projections provided on said lower substrate wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 53 nm at said twist angle of about 40 degrees and about 10 to 64 nm at said twist angle of about 65 degrees, respectively.

26. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 75 to 120 degrees and a light diffusive reflective electrode having recesses and projections provided on said lower substrate wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 74 nm at said twist angle of about 75 degrees and about 10 to 101 nm at said twist angle of about 120 degrees, respectively.

27. A liquid crystal display device comprising:

an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 0 to 30 degrees and a light diffusive reflective electrode having recesses and projections provided on said lower substrate wherein a product of said height of

said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 32 nm at said twist angle of about 0 degrees and about 10 to 47 nm at said twist angle of about 30 degrees, respectively.

28. A method of fabricating a liquid crystal display device comprising the steps of:

providing an upper substrate and a lower substrate disposed in a mutually facing relation;

providing a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 40 to 65 degrees;

providing a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

providing a phase plate provided on an outer surface of said upper substrate;

providing a polarizing plate provided on an outer surface of said phase plate; and

wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 53 nm at



said twist angle of about 40 degrees and about 10 to 64 nm at said twist angle of about 65 degrees, respectively.

29. The method of claim 28 wherein said liquid crystal layer has a retardation in the range of about 200 to 350 nm.

30. The method of claim 28 wherein said phase plate has a retardation in the range of about 280 to 470 nm.

31. The method of claim 28 wherein said phase plate has a slow axis azimuth in the range of about 30 to 75 degrees.

32. The method of claim 28 wherein said phase plate has an Nz coefficient of less than about 0.5.

33. The method of claim 28 wherein said polarizing plate has an absorption axis azimuth in the range of about 30 to 90 degrees.

34. The method of claim 28 wherein said liquid crystal layer has a retardation in the range of about 380 to 450 nm at a twist angle in the range of about 45 to 50 degrees.

35. The method of claim 28 wherein said phase plate has a retardation in the range of 280 to 340 nm at a twist angle in the range of about 45 to 50 degrees.

36. The method of claim 28 wherein said phase plate has a slow axis azimuth in the range of about 5 to 50 degrees at a twist angle in the range of about 45 to 50 degrees.

37. The method of claim 28 wherein said polarizing plate has an absorption axis azimuth in the range of about 0 to 10 degrees and in the range of 125 to 180 degrees at a twist angle in the range of about 45 to 50 degrees.

38. A method of fabricating a liquid crystal display device comprising the steps of:

providing an upper substrate and a lower substrate disposed in a mutually facing relation;

providing a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 75 to 120 degrees;

providing a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

providing a phase plate provided on an outer surface of said upper substrate;

providing a polarizing plate provided on an outer surface of said phase plate; and

wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 74 nm at said twist angle of about 75 degrees and about 10 to 101 nm at said twist angle of about 120 degrees, respectively.

39. The method of claim 38 wherein said liquid crystal layer has a retardation in the range of about 200 to 310 nm.

40. The method of claim 38 wherein said phase plate has a retardation in the range of about 320 to 460 nm.

41. The method of claim 38 wherein said phase plate has a slow axis azimuth in the range of about 105 to 145 degrees.

42. The method of claim 38 wherein said polarizing plate has an absorption axis azimuth in the range of about 25 to 65 degrees.

43. The method of claim 38 wherein said liquid crystal layer has a retardation in the range of about 200 to 310 nm at a twist angle in the range of about 75 to 80 degrees.

44. The method of claim 38 wherein said phase plate has a retardation in the range of about 320 to 460 nm at a twist angle in the range of about 75 to 80 degrees.

45. The method of claim 38 wherein said phase plate has a slow axis azimuth in the range of about 105 to 145 degrees at a twist angle in the range of about 75 to 80 degrees.

46. The method of claim 38 wherein said polarizing plate has an absorption axis azimuth in the range of about 25 to 65 degrees at a twist angle in the range of about 75 to 80 degrees.

47. A method of fabricating a liquid crystal display device comprising the steps of:

providing an upper substrate and a lower substrate disposed in a mutually facing relation;

providing a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 0 to 30 degrees;

providing a light diffusive reflective electrode having recesses and projections provided on said lower substrate;

providing a phase plate provided on an outer surface of said upper substrate;

providing a polarizing plate provided on an outer surface of said phase plate; and

5 wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 32 nm at said twist angle of about 0 degrees and about 10 to 47 nm at said twist angle of about 30 degrees, respectively.

10 48. The method of claim 47 wherein said liquid crystal layer has a retardation in the range of about 200 to 370 nm.

49. The method of claim 47 wherein said phase plate has a retardation in the range of about 10 to 240 nm.

50. The method of claim 47 wherein said phase plate has a slow axis azimuth in the range of about 95 to 175 degrees.

15 51. The method of claim 47 wherein said polarizing plate has an absorption axis azimuth in the ranges of about 0 to 25 degrees and about 165 to 180 degrees.

52. A method of fabricating liquid crystal display device comprising the steps of:

5 providing an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 40 to 65 degrees and a light diffusive reflective electrode having recesses and projections provided on said lower substrate wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 53 nm at said twist angle of about 40 degrees and about 10 to 64 nm at said twist angle of about 65 degrees, respectively.

10 53. A method of fabricating a liquid crystal display device comprising the steps of:

15 providing an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 75 to 120 degrees and a light diffusive reflective electrode having recesses and projections provided on said lower substrate wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 74 nm at said twist angle of about 75

degrees and about 10 to 101 nm at said twist angle of about 120 degrees, respectively.

54. A method of fabricating a liquid crystal display device comprising the steps of:

5 providing an upper substrate and a lower substrate disposed in a mutually facing relation and a liquid crystal layer sandwiched between said upper substrate and said lower substrate having a twist angle in the range of about 0 to 30 degrees and a light diffusive reflective electrode having recesses and projections provided on said lower substrate wherein a product of said height of said recesses and projections and a birefringence of said liquid crystal layer is in the range of about 10 to 32 nm at said twist angle of about 0 degrees and about 10 to 47 nm at said twist angle of about 30 degrees, respectively.

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